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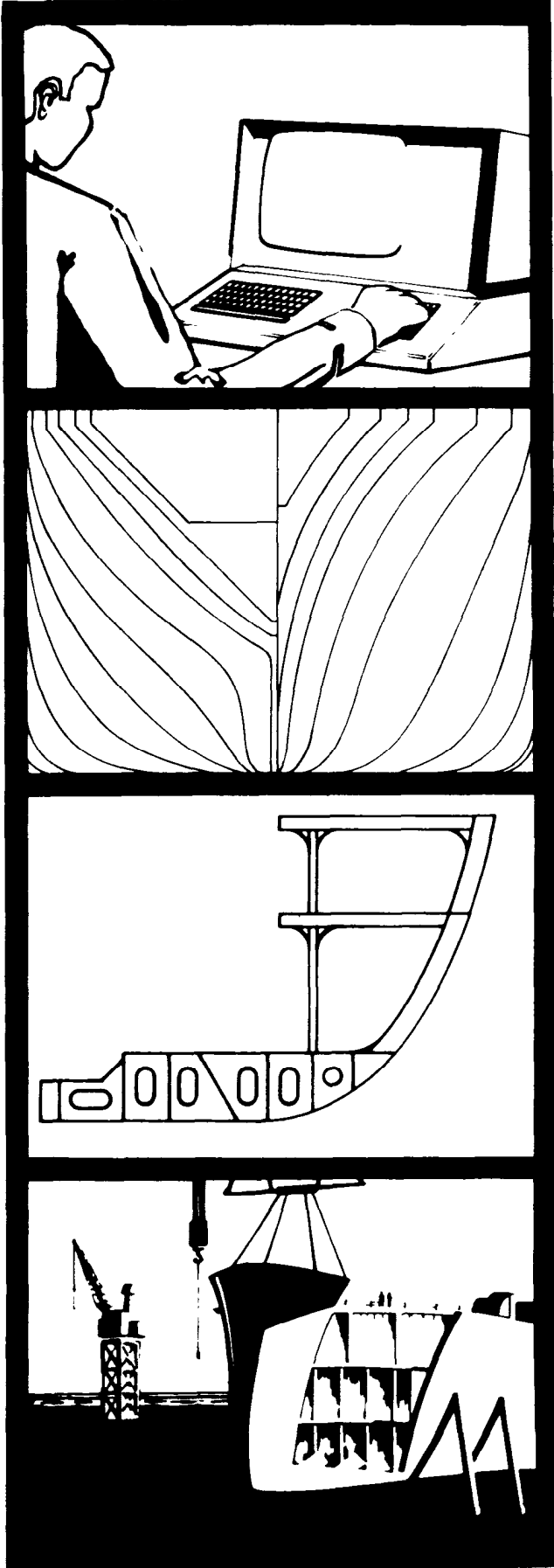
### **Paper No. 20: Automated Handling for Flame Cutting**

U.S. DEPARTMENT OF THE NAVY  
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## **AUTOMATED HANDLING FOR FLAME CUTTING**

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### **ABSTRACT**

**Steel plate handling, in support of flame cutting machines, is usually the major factor limiting the machine's productivity. This is particularly true with the new, faster CNC controlled machines equipped with plasma-arc cutting equipment used in conjunction with water tables.**

**This paper provides the essential principles and stages of plate handling for a shipyard cutting operation. Typical solutions for both the existing shipyard and the new facility are covered, focusing on the importance of automated equipment to attain maximum production levels and peripheral benefits from today's fast, dependable, and accurate cutting machines. Efficient use of the proper equipment produces cost saving benefits by minimizing labor-intensive stations and providing accurate cut parts to maximize the employment of fixture and robot welding.**

Modern flame cutting equipment, incorporating the latest technologies of computer nesting, CNC Control, and the underwater plasma-arc process, delivers dependability and speed. Used in conjunction with a water table, today's cutting operations incorporate several peripheral benefits such as pollution control, quenching of, and ease of handling cutting waste, noise reduction, safety, and above all - improved cut-part accuracy. In one shipyard, the benefits of increased cutting speed and accuracy, from a new CNC controlled underwater plasma cutting operation, saved substantial man hours of cutting, fit-up, and fabrication time on the second of two (2) identical vessels.

Current on-going tests of part accuracy, from various sources, are yet to be tabulated, but initial findings are exciting. Exciting in that all indications point to the ultimate cost-saving benefits by minimizing labor intensive, part cleaning, and maximizing the employment of fixture welding and robot welding.

It is the productivity, accuracy, and the resulting downstream assembly savings that make modern CNC plasma cutting equipment attractive even to the smaller shipyard. Of course, the faster cutting machines must be fed fresh plate and cleared of cut parts more quickly in order to achieve their output capabilities. Just how this plate and part handling is achieved may vary from facility to facility. An operating shipyard with a heavy investment in existing facilities, and limited funds or space for capital improvement, will solve their problem one way. A new facility with adequate budgetary appropriation, eagerly searching for the latest and the ultimate in equipment, may solve their problem in a far different manner.

An analysis of handling starts with examination of product mix, number of plates per hour, per shift, per day, etc.; number of cut parts, crane capabilities, present handling methods, handling speeds, floor space, floor plan, material flow, number of laydown stations, lighting, noise, cut-part routing, cleaning stations, and of course, bottlenecks.

No one solution is sacred. Each application requires analysis of the unique production problems and reduction to a solution that suits your situation best. Two (2) prerequisite goals should be applied:

1. Minimize the number of plate sizes inventoried. Savings generated by volume raw material purchase will help amortize the project.
2. Establish minimum cut-part inventory levels to prevent emergency interruption of scheduled production.

**MATERIAL HANDLING SYSTEMS SHOULD ADHERE TO THE FOLLOWING PRINCIPLES:**

1. Work should move in an uninterrupted flow.
2. Material transfer time should be low; -never exceeding the processing operation itself.
3. The processing line should be self-sufficient - not requiring external assistance.
4. The process line should occupy a minimum amount of floor space.
5. Material should not be handled more times than necessary.

If we adhere to the five (5) basic principles, listed previously, and focus on an optimum solution to cutting room efficiency - we have to consider the following eight (8) essential stages. Each must be evaluated with an eye toward manpower requirements.

1. Raw material storage may dictate handling methods and access to the cutting area.
2. Raw material staging; -Ideally, there should be a stockpile of horizontally oriented plate, positioned adjacent to the load station or stations in sequence for the work schedule of that shift.
3. Load Station & Load Apparatus; -Should provide the actual loading and squaring of plate while the previous plate is being cut. Full plates should be easily handled with vacuum or magnets on a dedicated handling device which will provide proper plate orientation.
4. The Cutting Station; -Must be accessible for rapid loading without additional lifting or handling. It must be cleared of an infinite variety of cut parts, scrap, and waste and must provide effective and 'complete pollution control.
5. Part & Skeleton Removal; -Should allow cut parts and skeleton (scrap) to be removed rapidly. It is best served by a dedicated piece of handling equipment.
6. Parts Sorting & Skeleton Disposal; -Should be performed nearby and cleared quickly to accept material and allow time exposure for sorting of parts and disposing of skeleton. Delays in processing here can feed back into the cutting process. Handling skeletons in one piece is desirable in many cases. Processing of scrap should be carefully analyzed.



7. Part Cleaning; -In today's technology, good cutting, properly controlled, can deliver virtually dross-free parts. For those parts requiring cleaning, labor intensive cleaning stations should, if possible, be avoided in favor of mechanical cleaning machines.
8. Waste Disposal. Waste disposal should be simple. Waste should not be allowed to accumulate to a point where it affects cut quality or where it becomes a handling problem. Waste disposal should not cause cutting machine shutdowns for extended periods of time.

#### MULTIPLE TABLE TANDEM ARRANGEMENTS

(Diagram #1)

A multiple table arrangement can increase production by providing multiple plate laydown stations which will enable a single burning machine to operate over one table while plate is being placed on a second, and cut parts and skeletons are removed from a third. This is ideal for heavy plate oxy-fuel cutting and can achieve torch time of 60 - 70% or greater.

Multiple table arrangements can require: 1) a cutting machine operator, 2) a crane operator, 3) a sorter, and 4) a material handler. Each plate is handled multiple times and the cutting cycle is governed to some degree by the handling cycle on an off the table.

#### TANDEM ZONED TABLE ARRANGEMENT

(Diagram #2)

Operating yards often times find multiple water tables to be an excellent solution. Further, since much shipyard cutting is plate "trimming", and handling involves the movement of either whole plates or large single cut pieces, handling time is usually short and may not exceed the cutting/marking time per station. Here is a solution using two (2) zoned water tables that serve the shipbuilding industry's unique employment of large plate.

The two tables actually can provide either four (4) separately controlled cutting zones to accommodate 20'-0" plus ranges of plate, or two (2) zones (one (1) per table) to accommodate 50'-0" plus length of plate.

### IN-LINE PLATE PROCESSING SYSTEM

(Diagram #3)

An In-Line System, which is basically a conveyORIZED water table, will permit plates to be staged and loaded outdoors or in another bay, thus reducing floor space requirements in the cutting bay. The need for a dedicated overhead crane is minimized or eliminated. Instead, a much smaller crane can be used to load plate which is then passed, by the system, through a narrow building opening into the cutting area. Heat loss is eliminated.

Only two (2) men are required: 1) a cutting machine operator who remotely controls the plate loading crane, and 2) the unloading bridge operator who also remotely controls the pallet carrier for cut parts removal.

The result is a programmed, minimized interval between cutting cycles.

Torch time is maximized.

### IN-LINE PLATE PROCESSING SYSTEM FOR SHIPYARDS

(with automatic loading and semi-automatic unloading)

(Diagram #4)

The In-Line Plate Processing System can be constructed to accommodate "shipyard" size plate lengths with indexing speed and accuracy to support CNC plasma-arc mirror image cutting and marking. Such a system, in a recent analysis for a customer in the shipbuilding industry, with a cutting program of approximately 7.5 minutes per pair of plates, was shown to deliver 71.4% cutting time. With plate marking included as productive time in the cutting cycle, near 80% production time was reached. Loading and unloading take place within the cutting/marking cycle. Dual plate staging and dual cut-part stations are illustrated. The manpower requirement remains at only two (2) men; - a cutting machine operator who also remotely controls the loading crane and an unloading bridge operator who controls both unloading bridges.

IN-LINE PLATE PROCESSING SYSTEM - ELEVATION  
(with semi-automatic unloading for small parts)  
(Diagram #5)

Attention is called to the elevation view which helps explain the unloading sequence.

The unloading bridge carrying the unload operator, and equipped with a trolley and magnet assembly, is followed in very close proximity by the pallet carrier; remotely controlled by the same operator. Cut parts are magnetically lifted by the unload bridge and placed on the empty pallets on the pallet carrier. When the pallets are full, the pallet carrier moves to the extreme end (right) where it is accessible for unloading.

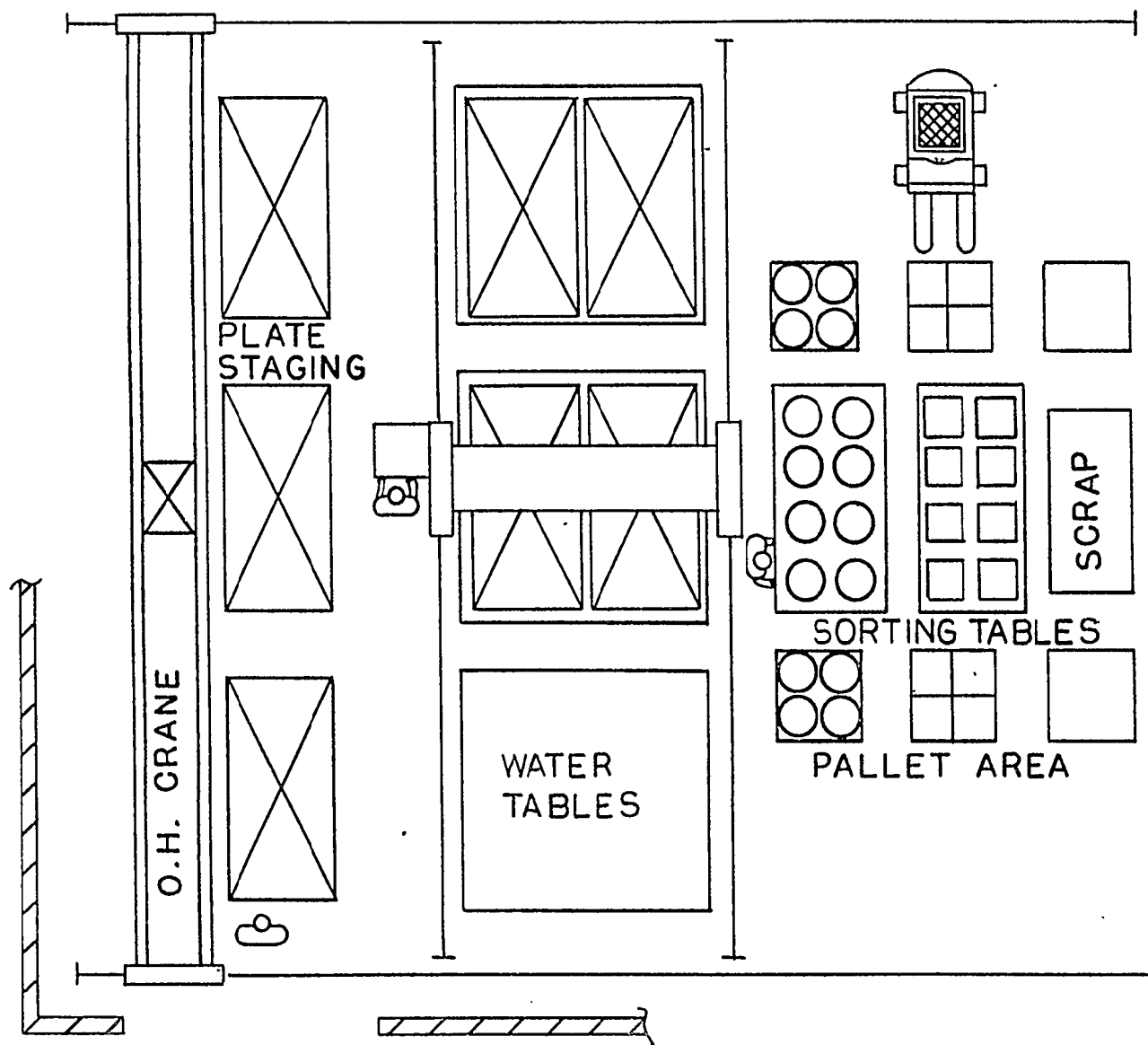
In a 5000 random cut-part study of an actual manufacturing situation, unloading was completed at the average rate of 6/10ths of a minute per part; -well within the average cutting time per piece in that sampling. Therefore, typically, the automated unloading cycle can be accomplished within the cutting cycle.

CONCLUSION

Analyze several systems. The optimum system should have a high throughput rate to justify to the initial investment. It is difficult to justify the expenditure for NC controlled plasma-arc equipment without marrying it to equipment that provides rapid indexing of plate and rapid handling of cut parts and scrap to achieve the high productivity and favorable economics that the plasma-arc process is capable of delivering.

Although there may be more than one answer in any given operation, if the homework is done well, it is not difficult to decide on the proper cutting process. By adhering to the basic handling principles, it is not difficult to wind up with a plate processing system that will enhance that cutting process, provide a handsome payback on the total investment in a minimum of production time; -and provide reasonable growth well into the future.

### 3 TABLE TANDEM ARRANGEMENT

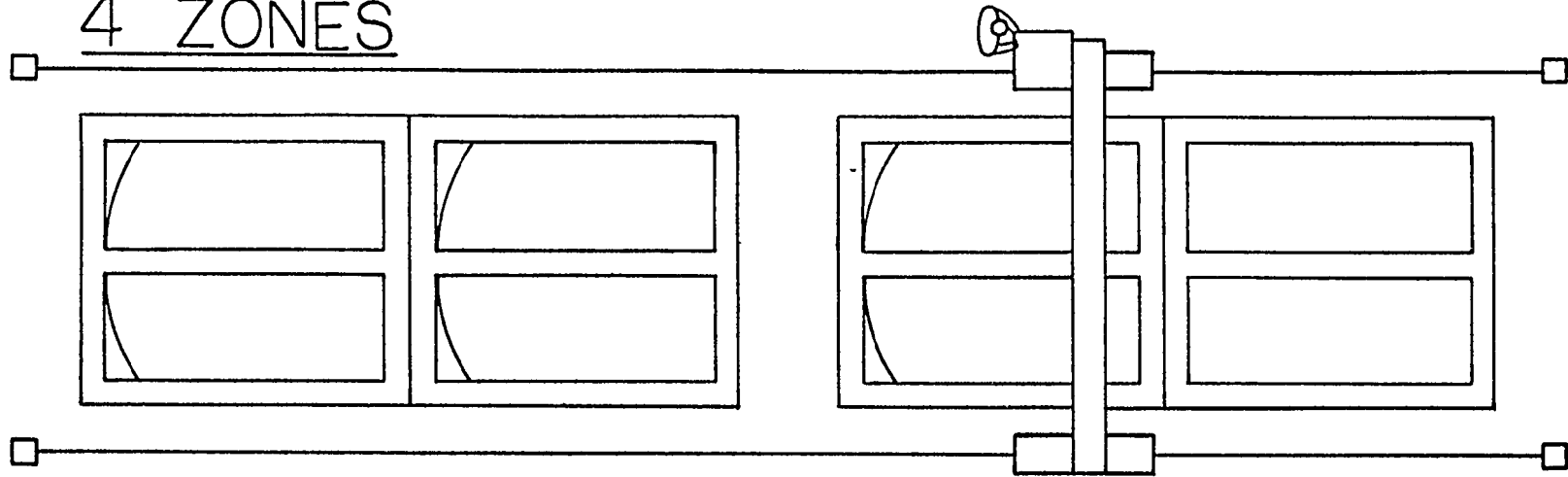


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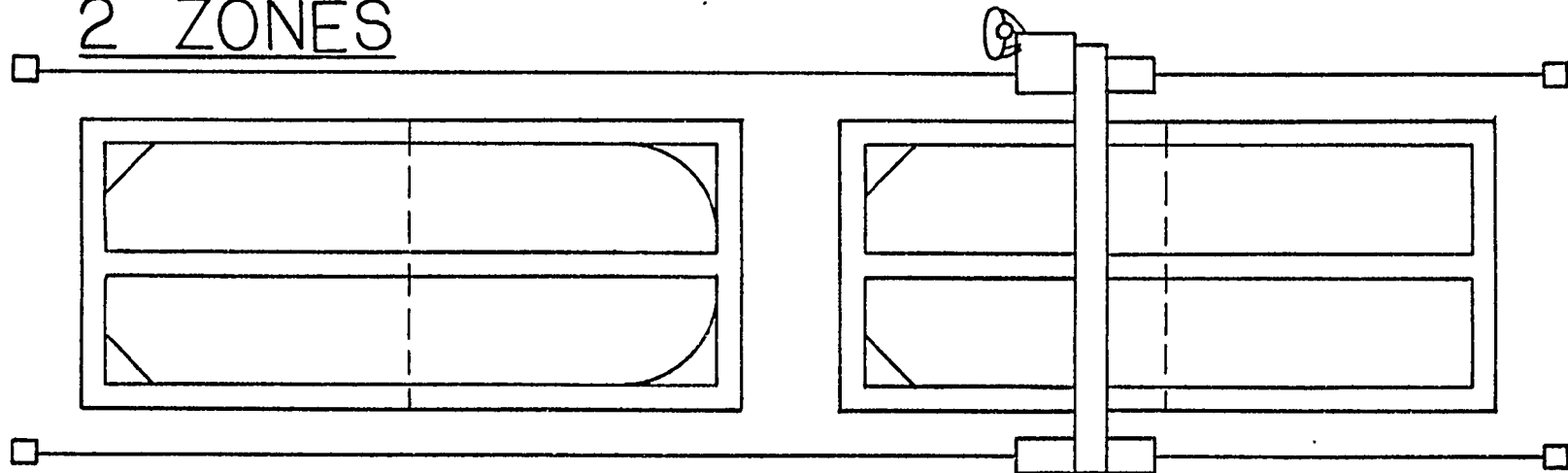
Diagram #1

# TANDEM ZONED WATER TABLES

## 4 ZONES



## 2 ZONES



# IN-LINE PLATE PROCESSING SYSTEM

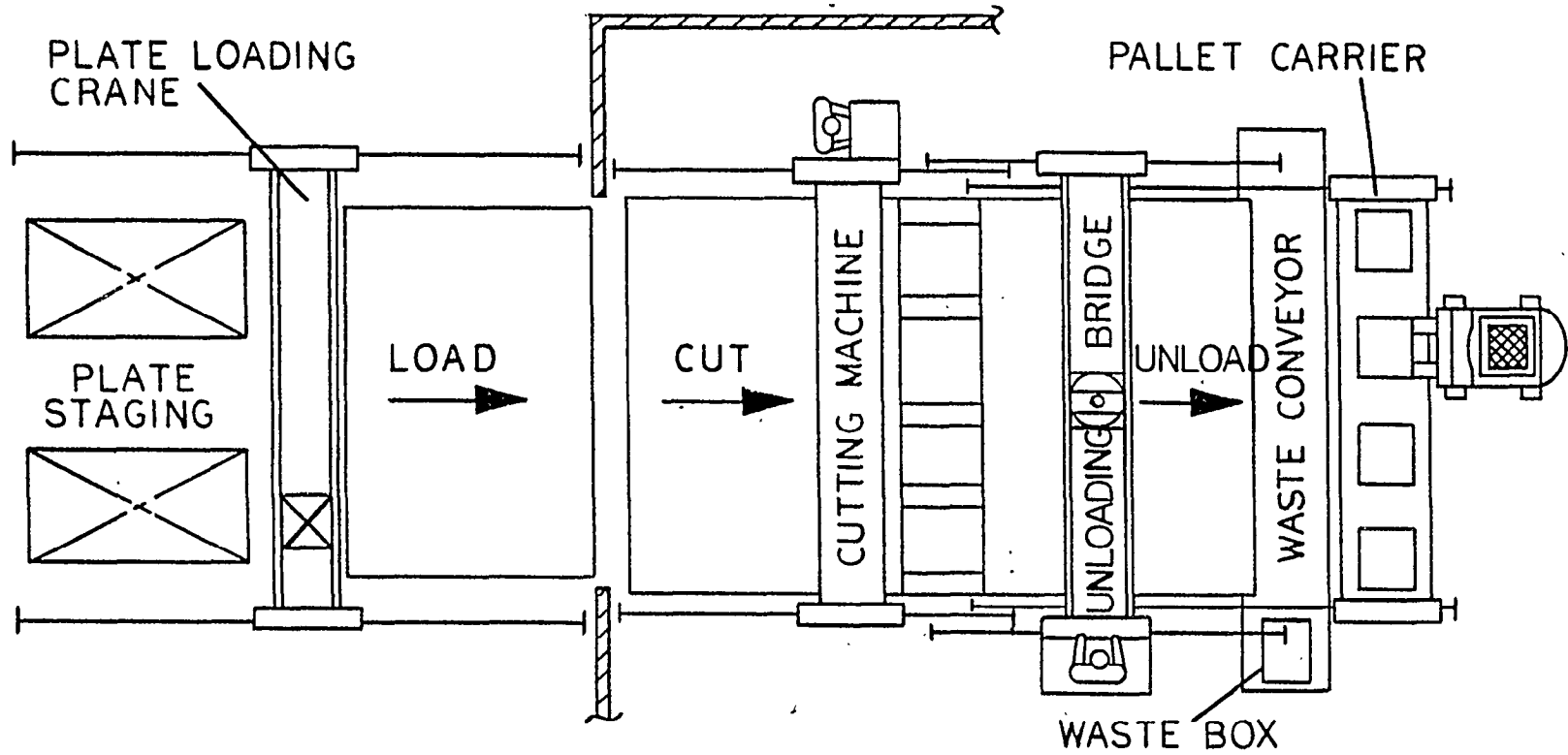
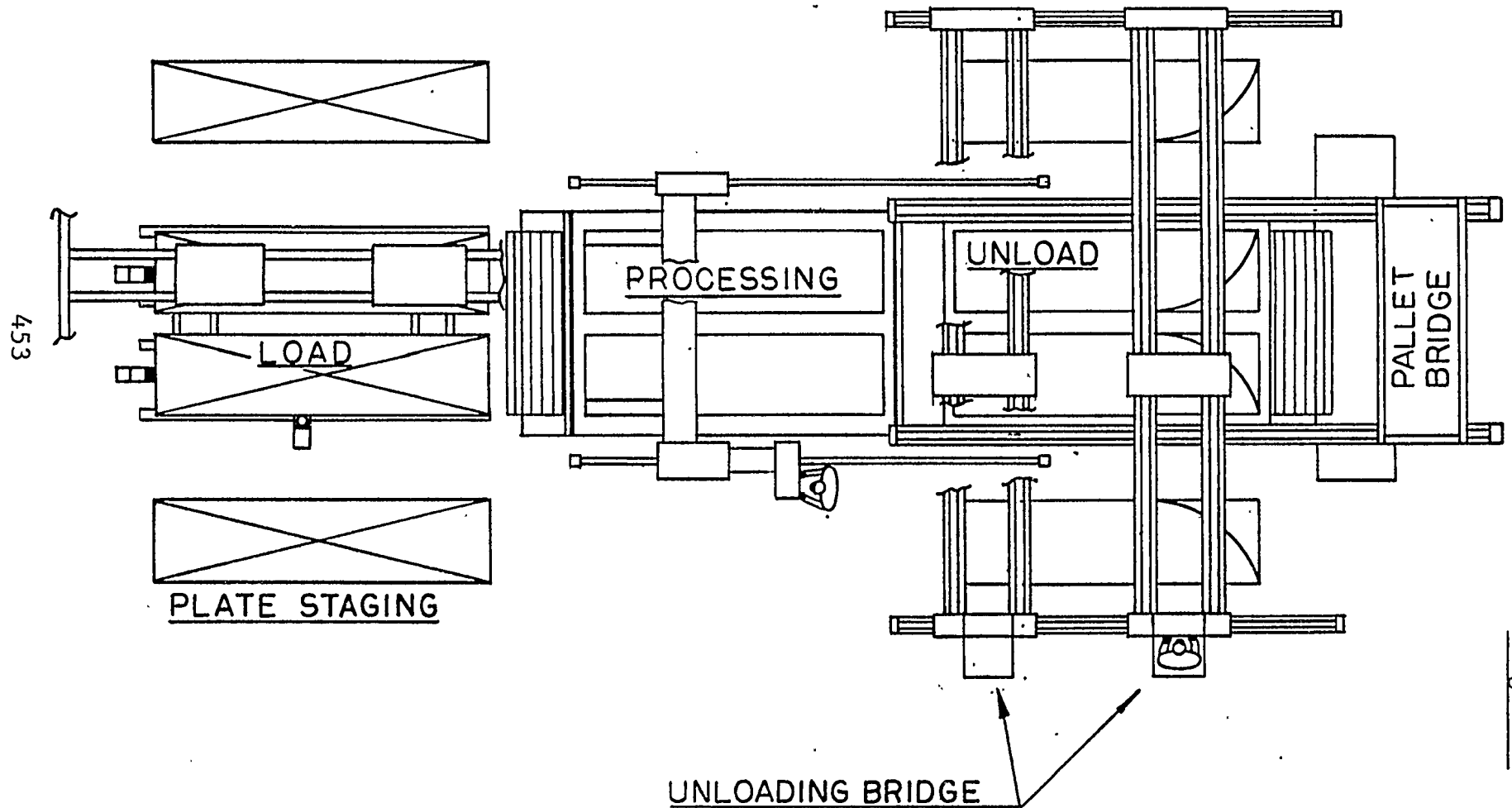


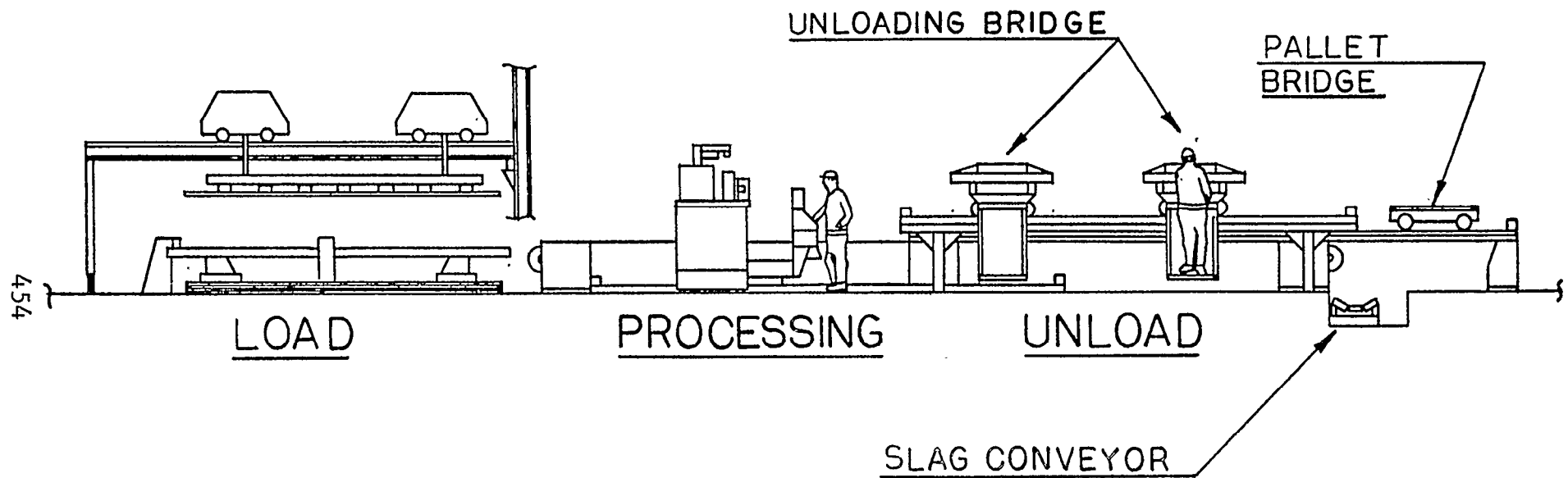
Diagram #3

# IN-LINE PLATE PROCESSING SYSTEM { WITH AUTOMATIC LOADING AND SEMI-AUTOMATIC UNLOADING } FOR SHIPYARDS



IN LINE PLATE PROCESSING SYSTEM  
(ELEVATION)

{ WITH AUTOMATIC LOADING  
AND SEMI-AUTOMATIC  
UNLOADING FOR SMALL PARTS }





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